

ADDENDUM No. 1

TO: ALL BIDDERS
FROM: CITY OF HIALEAH
BID #: 2013/14-9500-00-017
RE: HIALEAH ROWTP – PRODUCTION ABOVEGROUND BUILDING NO'S 8, 9, 12 & 13
DATE: JUNE 12, 2014

The original contract documents for the entitled: HIALEAH ROWTP – PRODUCTION ABOVEGROUND BUILDING NO'S 8, 9, 12 & 13 needs to be amended as noted in this Addendum No. 1.

This Addendum No. 1 consists of 1 typed page, 2 attachments, and 1 addendum receipt form (ARF). All other items and conditions of the original Contract Documents shall remain unchanged. This Addendum shall become a part of the Contract Documents.

Approved for issue:  Date: June 12, 2014
Angel Ayala – Acting Purchasing Director

ACKNOWLEDGMENT

Receipt of this Addendum No. 1 shall be acknowledged in the space provided on the ADDENDUM RECEIPT form – ARF (Copy attached) now a part of the Contract Documents to be faxed immediately to the City of Hialeah Purchasing Division (305) 883-5871 and submitted with sealed bids.

IN THE CONTRACT DOCUMENTS:

- A. Technical Specification Section 01010-A – Equipment & Material Inventory List
 - 1. **REPLACE** entire specification 01010-A with attached 01010-A
- B. Technical Specification Section 13320 – System Integration Requirements
 - 1. **REPLACE** entire specification 13320 with attached 13320

QUESTION:

Q1. What is the budget for this project?

A1. Total installed cost would be \$600k-800k.

CITY OF HIALEAH

HIALEAH ROWTP – PRODUCTION ABOVEGROUND BUILDING NO'S 8, 9, 12 & 13

BID #2013/14-9500-00-017

ADDENDUM No. 1

CONTRACTOR'S NAME _____

ADDRESS _____

PHONE NO. _____

CONTACT NAME _____ SIGNATURE _____

THE BIDDER ACKNOWLEDGES RECEIPT OF THE FOLLOWING ADDENDUM BY SIGNING AND DATING BELOW:
(Copy of this form must be faxed immediately to the City of Hialeah at (305) 883-5871).

ADDENDUM

SIGNATURE

DATE

1

SECTION 01010-A

EQUIPMENT & MATERIAL INVENTORY LIST

The "Equipment & Material Inventory List" for the Hialeah ROWTP Wells Building No's 8,9,12 and 13 is shown in **Table 1** below. These items will be provided by the City of Hialeah for incorporation into the project by the Contractor in conjunction with the scope of work of this Bid Package.

Table 1. Hialeah ROWTP Future Production Wells Equipment & Material Inventory

Trade	Equipment/Material	Quantity Onsite	Quantity to be turned over to Contractor	Comments (as applicable)
Piping	Horizontal Pipe assembly consisting of three (3) 10" Venturi FM	3	3	Assemble does not include the well head Flange that was provided by Layne
Piping	Floor Sleeves	4	4	
Piping	Pipe Alignment Frame	1	1	
Piping	Pipe Supports	2	2	
Piping	Sets of 1/2" st/st sample and Instrument Piping	4	4	
Roof	Short Trusses (Overhang)	24	24	See Figure 9 for Condition
Roof	Long Trusses (Interior)	24	24	See Figure 9 for Condition
Roof	Bundles of 1" angle Brace Supports (unprimed)	5	5	See Figure 1 for Condition
Roof	Full length 1" angle	20	20	
Roof	Truss Wall Clips	9	9	
Roof	Bundles of 11 Sheets of Galvanized Decking	4	4	
Building	Wall embeds	134	134	
Building	Double Door Frame	9	4	
Building	Doors	8 (4 Pairs)	8 (4 Pairs)	
Building	Double Door Threshold	2	2	
Building	Sets of Door Weather Stripping	4	4	

Trade	Equipment/Material	Quantity Onsite	Quantity to be turned over to Contractor	Comments (as applicable)
Building	PW Sign	8	4	
Building	Sets of Double Door Hinges	4	4	
Building	Door Slide Bolt	4	4	
Building	Door Lock	4	4	
Building	Door Closure	8	8	
Building	Door Push Bar Exit Device	8	8	
Fire and Security	FACP (Box only)	4	4	
Fire and Security	Cabinet Battery Box	11	8	
Fire and Security	PSC 12 Final Assembly	4	4	
Fire and Security	CAB2-BD Closure Assembly	8	4	
Fire and Security	CCS Module CardCage KG	4	4	
Fire and Security	Fire Finder XLS	3	3	
Fire and Security	4A Zone Indicating Card	6	6	
Fire and Security	HMS-S Pull Station	4	4	
Fire and Security	ZH-MC-R Horn Strobe w/ Base	8	8	
Fire and Security	RM-DCM-2 Door Control Module	4	4	
Fire and Security	HTRI-D Switch Interface Module	4	4	
Fire and Security	DS160 Request-to-Exit Interface Detector	1	1	
Fire and Security	Backup Battery	3	3	
Fire and Security	WP2000 Weatherproof Enclosure	10	8	
Instrumentation	ABB FIT (Flow meter)	6	4	
Instrumentation	ABB FIT Valve Block	14	4	
Instrumentation	ABB PIT	8	4	
Instrumentation	ABB PIT Bleed Valve	18	4	
Instrumentation	Ashcroft PSL (Low pressure switch)	8	4	

Trade	Equipment/Material	Quantity Onsite	Quantity to be turned over to Contractor	Comments (as applicable)
Instrumentation	Ashcroft 100 Psi Pressure Gauge	15	12	
Instrumentation	E&H Waterpilot Level Probe	4	4	
Instrumentation	PIT Pipe Bomb	6	4	
Fencing	Rolls of 8' Tall Black Chain Link	35	35	
Fencing	15' - 1 1/2" Fence Post	16	16	
Fencing	10' - 1 1/2" Fence Post	37	37	
Fencing	10' - 2" Fence Post	6	6	
Fencing	10' - 3" Fence Post	6	6	
Fencing	10' - 4" Fence Post	8	8	
Well Material/Equipment	Well Column Piping Section	56	28	
Well Material/Equipment	Well Pump	8	4	
Well Material/Equipment	Well Motor (Hitachi 125 HP)	3	3	Motors need new leads
Electrical	125 HP VFD	7	4	
Electrical	Power Panel Cabinet	8	4	
Electrical	RTU Control Panel	8	4	
Electrical	Surge Protection Device	13	8	
Electrical	Generator Distribution Panel	8	4	
Electrical	30A Disconnect Switch for AC unit	9	4	
Electrical	Radio Telemetry Aerial	4	4	
Electrical	Control Transformers	3	3	
Electrical	Well Pump Electrical Dist. Box Panel and Door set	8	4	
Electrical	Breakers - 15A	4	4	
Electrical	Breakers - 20A	28	28	
Electrical	Breakers - 60A	4	4	

Following pictures illustrate some of the Equipment and Inventory listed in **Table 1** above.

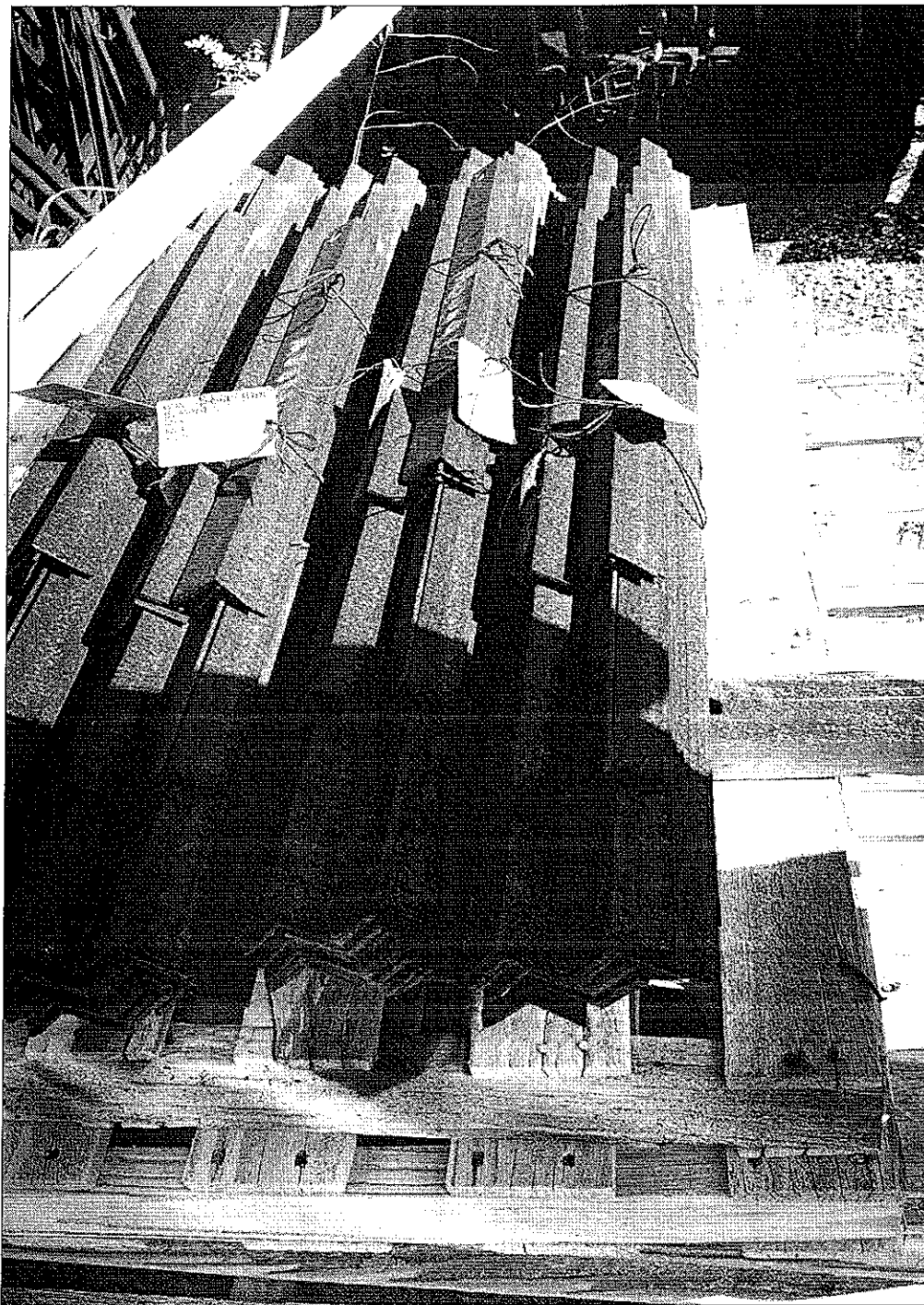


Figure 1. Angled Support Brackets

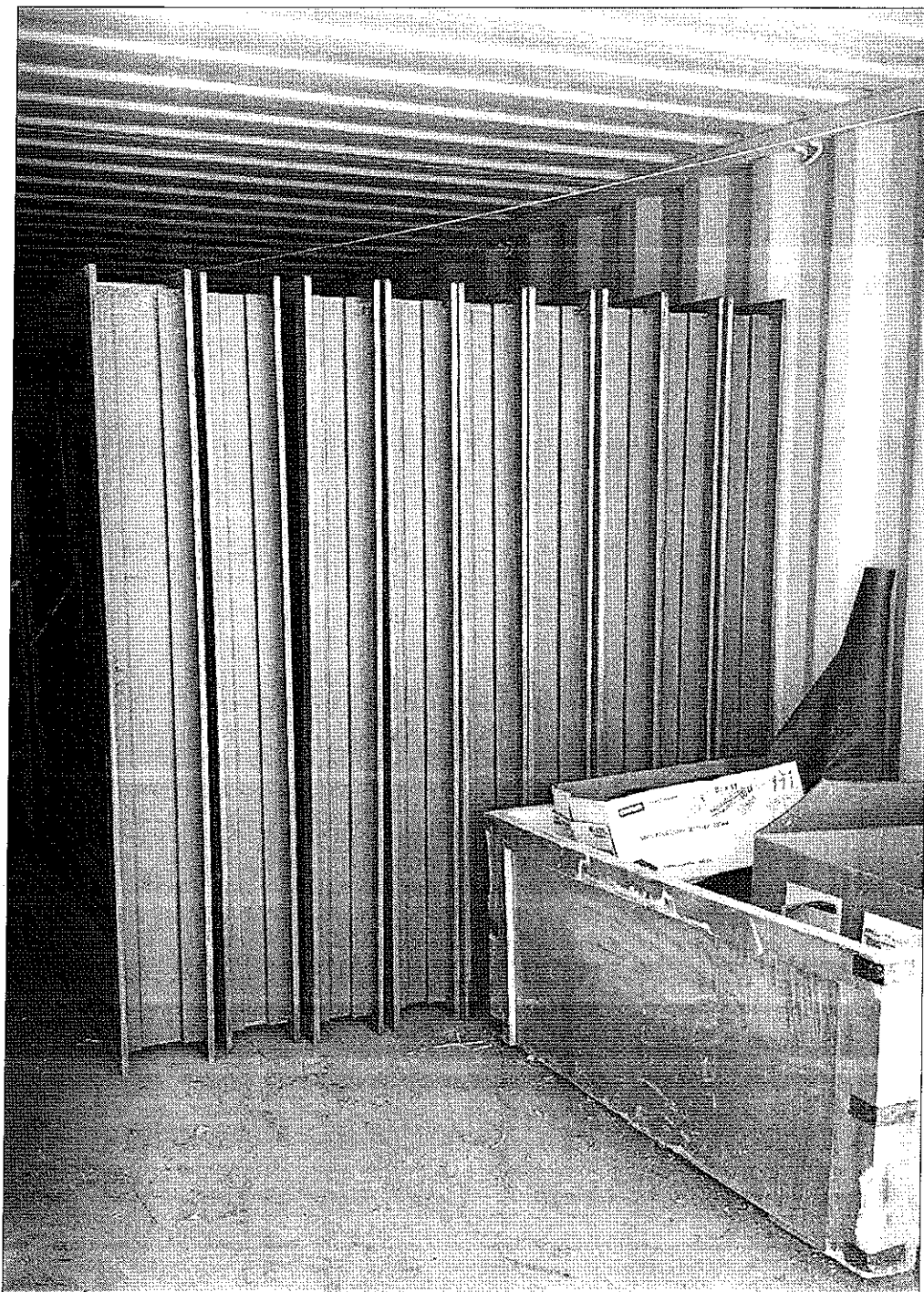


Figure 2. Door Frames



Figure 3. Doors, Weather Stripping, Door Hardware

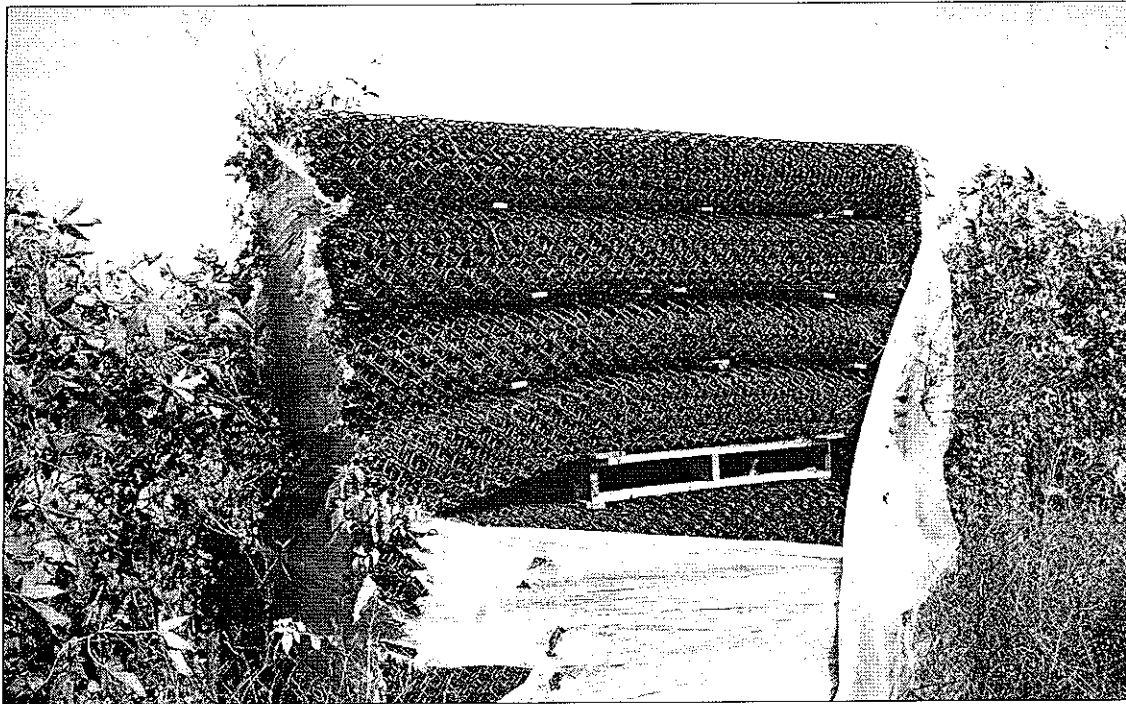


Figure 4. Fencing, Chain Link Bundles

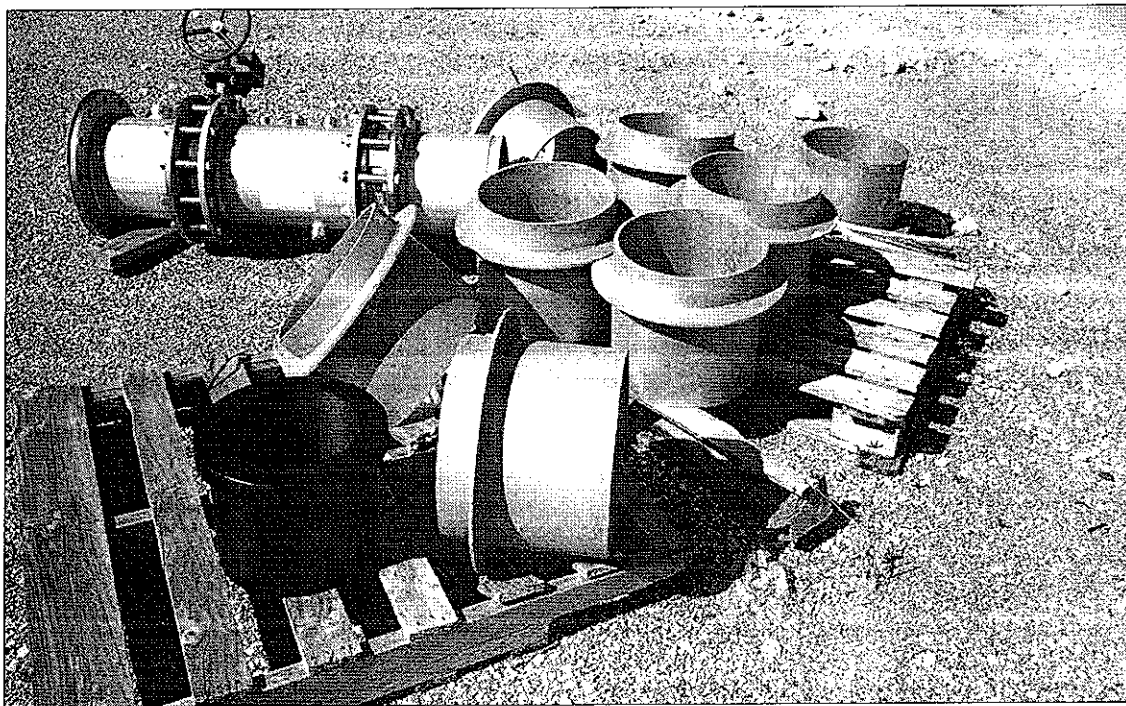


Figure 5. Floor Sleeves



Figure 6. Instrument SS Piping

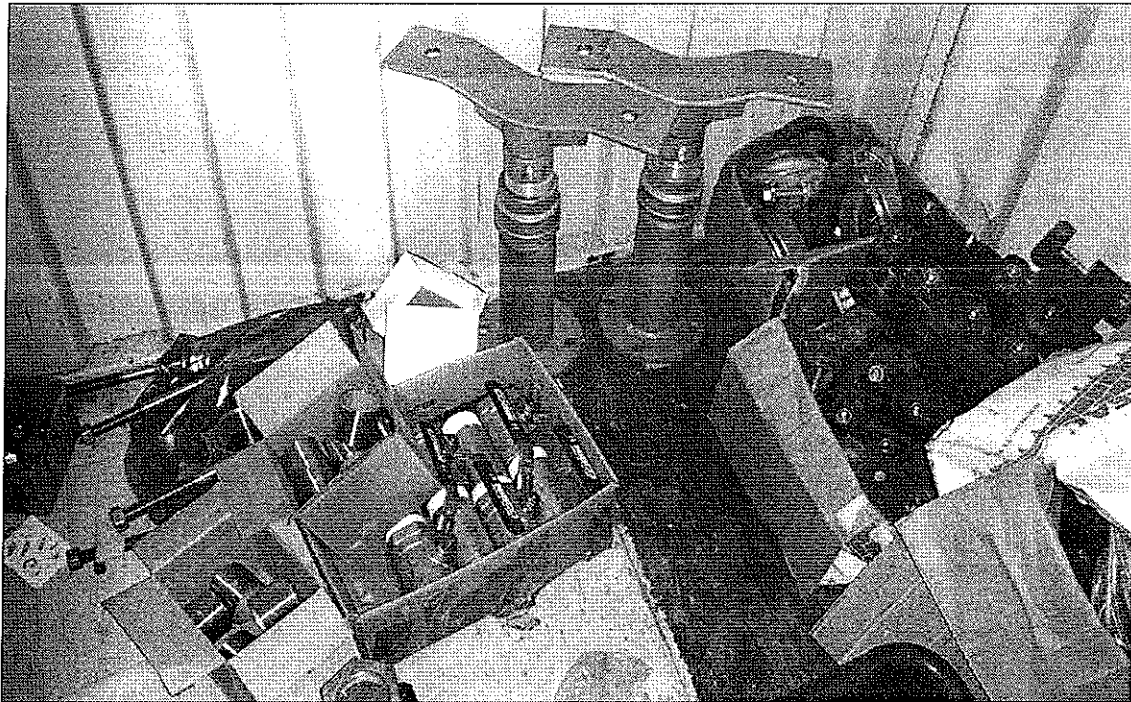


Figure 7. Pipe Supports

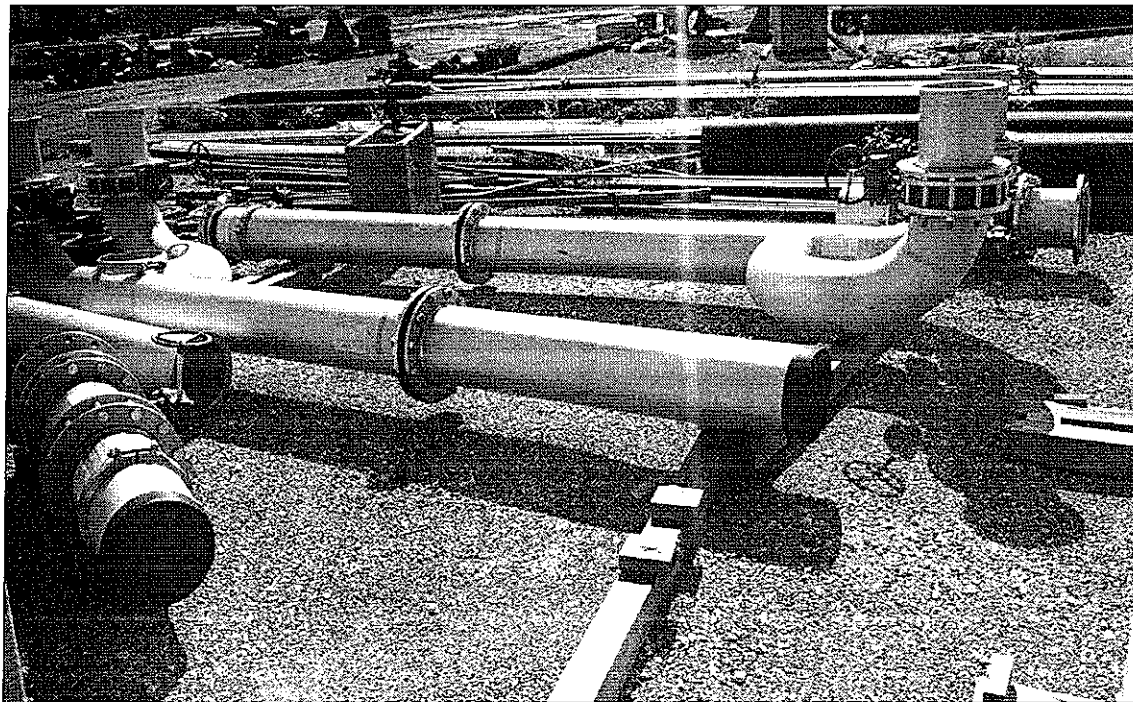


Figure 8. Well Horizontal Piping Assembly



Figure 9. Roof Trusses – 1

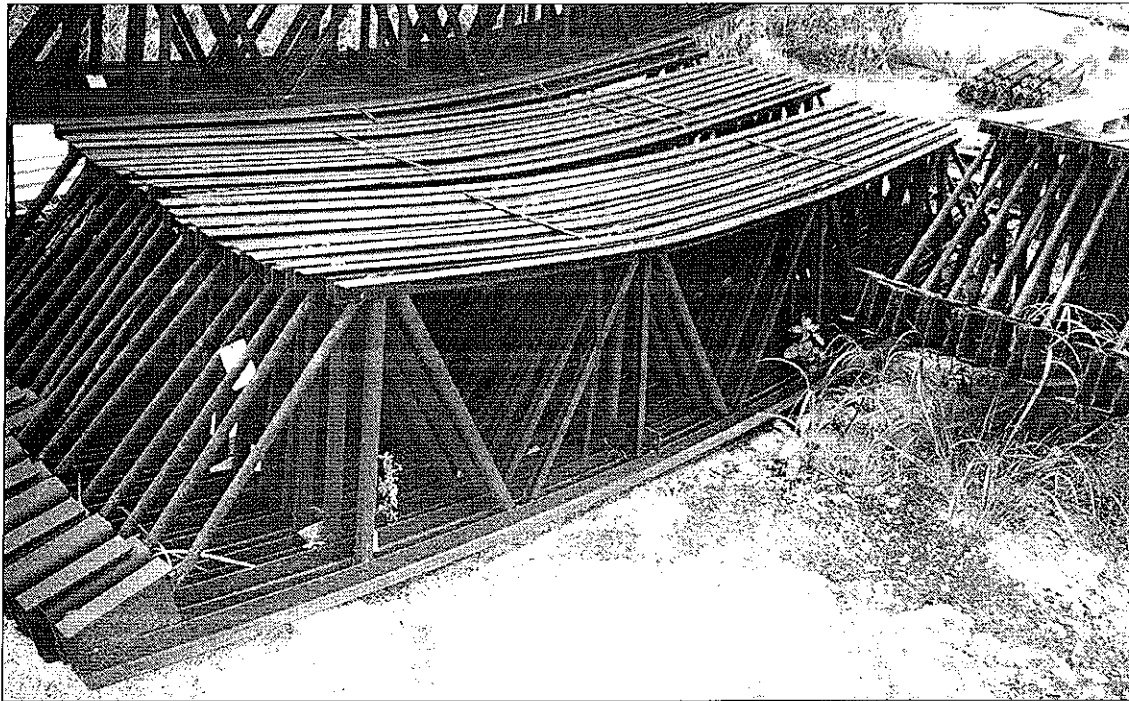


Figure 10. Roof Trusses -2



Figure 11. Well Pump VFDs

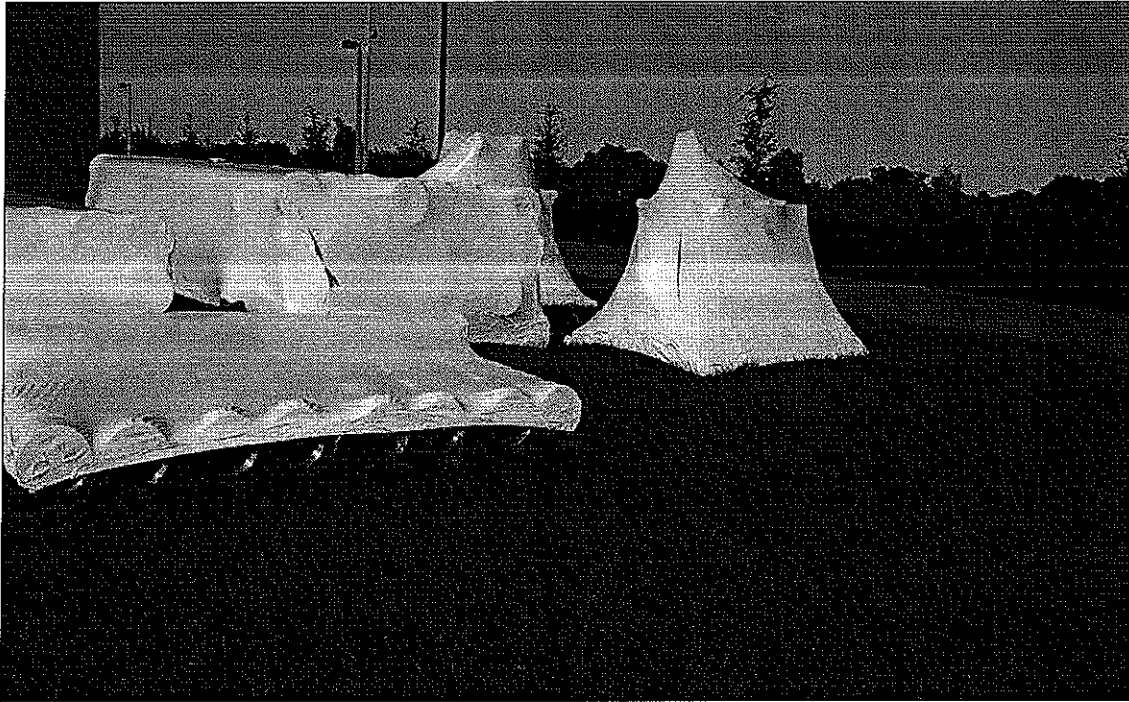


Figure 12. Well Pumps, Motors and Column Piping

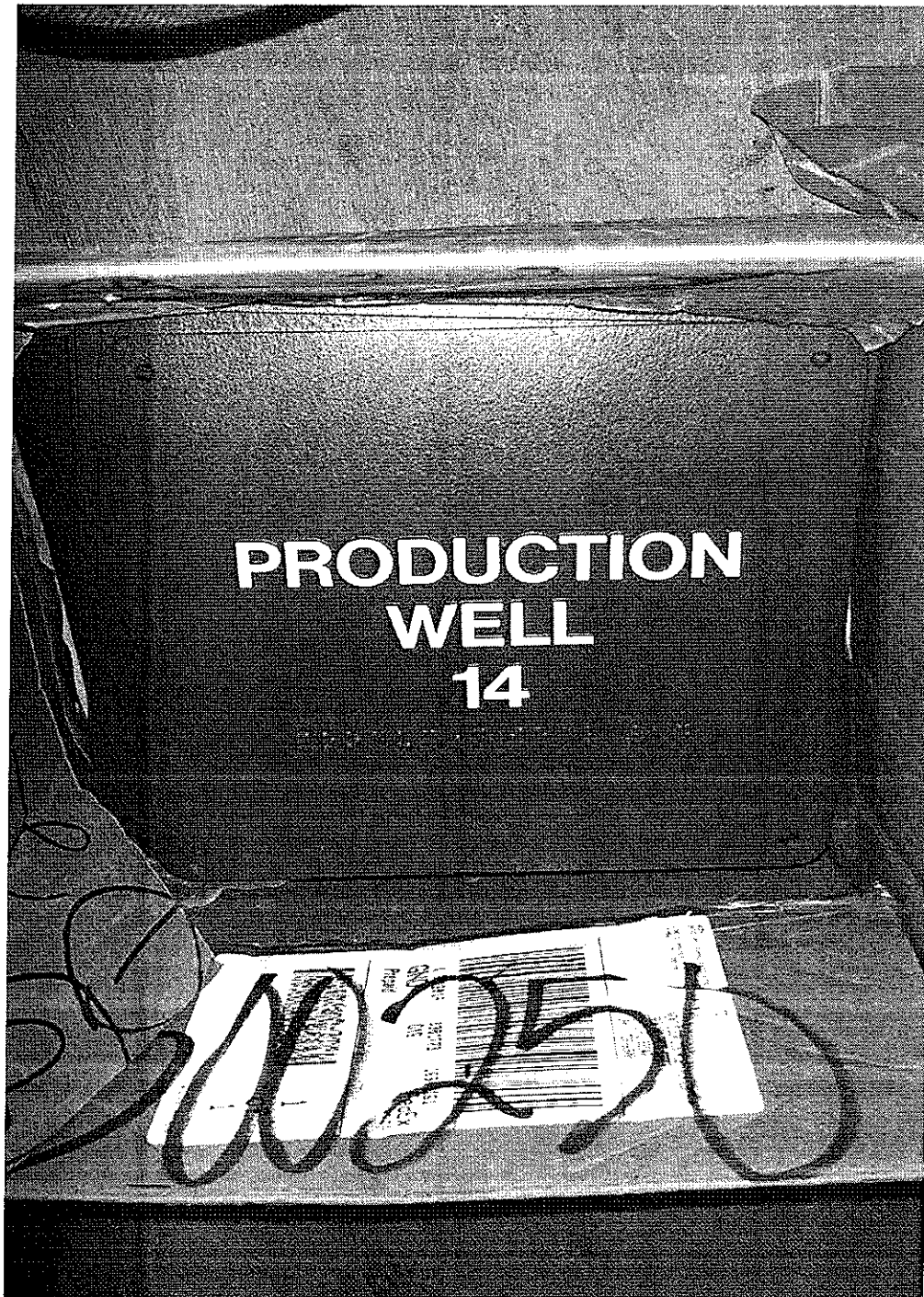


Figure 13. Production Well Signs

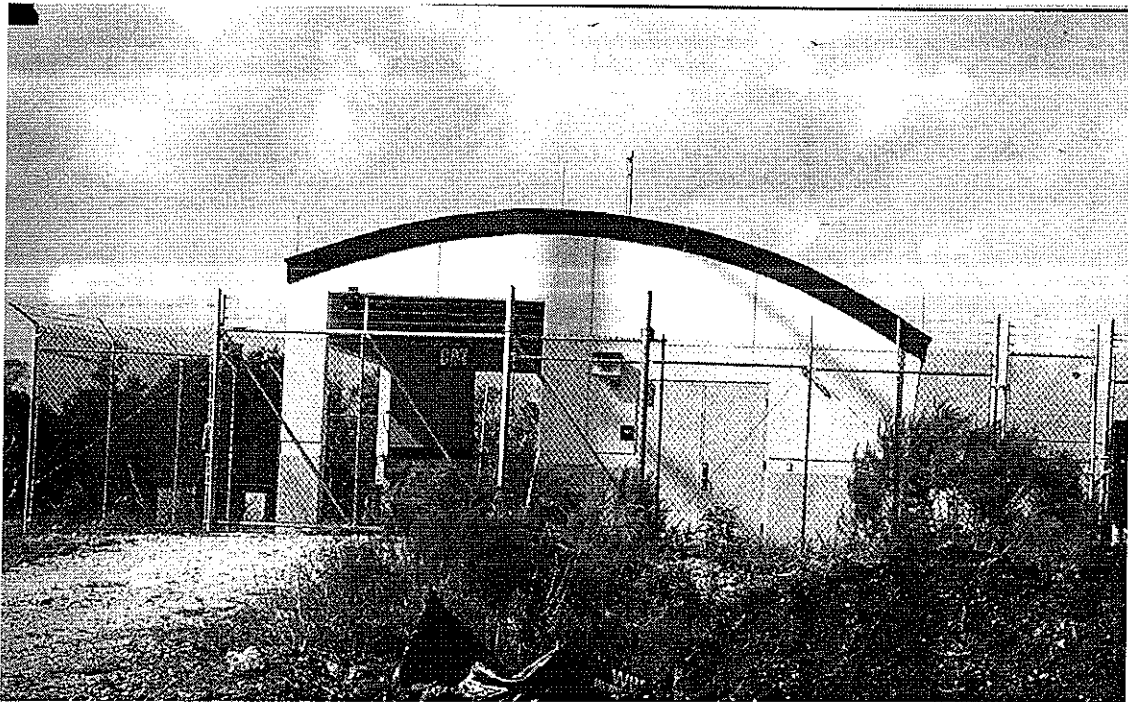


Figure 14. Production Well No.11 – Example for Proposed Graham Wells

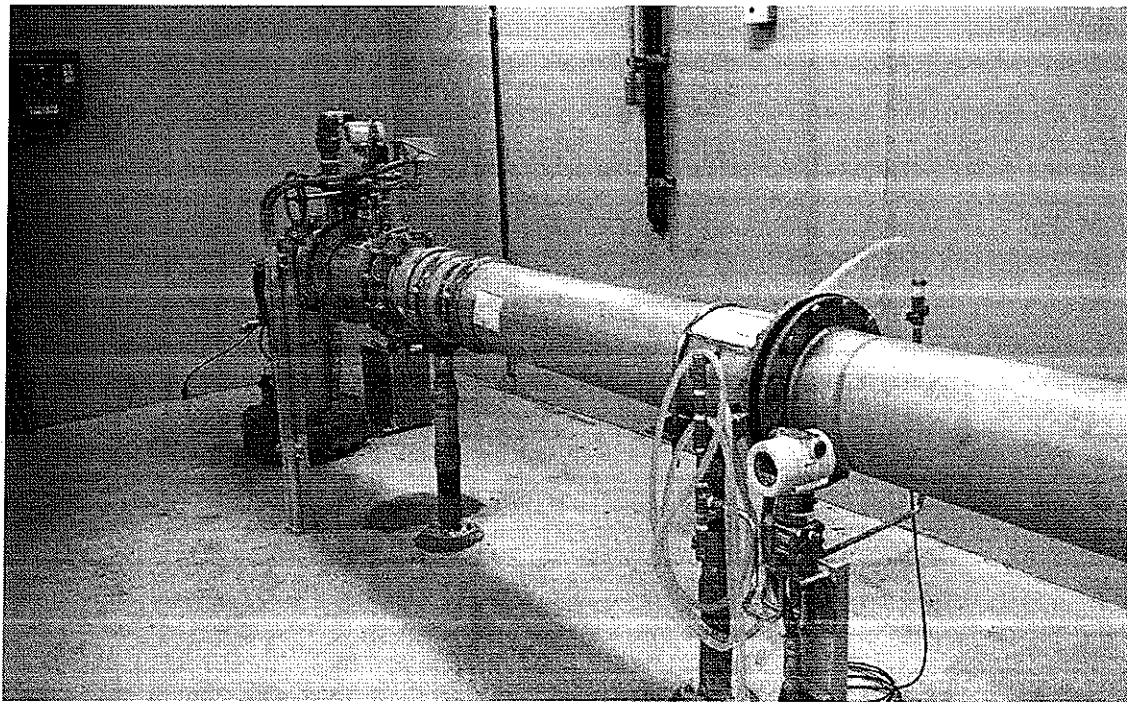


Figure 15. Production Well No.11 – Horizontal Piping Assembly



Figure 10. Production Well No.11– Roof Trusses

END OF SECTION

SECTION 13320
SYSTEMS INTEGRATION REQUIREMENTS

PART 1 - GENERAL REQUIREMENTS

- A. Contractor is advised to utilize the system Integrator, "Revere Controls" to install, set up, commission and integrate the Wells with the Hialeah ROWTP.
- B. Training
- C. Furnish what is required for complete and functioning system. Owner provided list is in 01010. Details herein do not imply the ancillary requirement for the system are not supplied by the Owner but in included should the hardware be required. Contractor is to be familiar with what is required prior to bid.

1.01 SCOPE

A. Requirements

Requirements specified in Division 1 of these Specifications form a part of Division 13. This Section covers the general requirements for furnishing and installation of the instrumentation, control and monitoring (ICM) system complete in every detail for the purposes specified and shall form a part of the other Sections of Division 13 unless otherwise specified. The other Sections of this Division shall supplement this Section as necessary. All work and documentation shall comply with all applicable local codes and ANSI and NFPA standards.

1. Work:

- a. The intent of Division 13 is to require that the complete Instrumentation, Control and Monitoring System, including the other Sections of this Division shall be furnished by a single Control Systems Integrator (CSI) to assure system uniformity, subsystem compatibility and coordination of system interfaces. Refer to Technical Speciation 01010 Summary of Work for additional information.
- b. Provide a complete and functional Supervisory Control and Data Acquisition (SCADA) system as described herein, as per the project specifications, and as shown on the drawings. The system is comprised of Distributed I/O (DIO) and/or Remote I/O (RIO) with equipment required to tie it into a redundant fiber optic Ethernet IP network, servers and operator workstations for the plant. Field instrumentation shall interface to the network via a readily locally serviceable protocol which may include Profibus DP and PA for valves, flow meters, pressure transmitters, and level transmitters. The SCADA system is to monitor and control all equipment. Materials, incidentals, software, supervision, and labor shall be provided under this Contract.
- c. Provide a means to tie the SCADA system monitoring and control to the City's existing SCADA system.
- d. Furnish the tools, equipment, materials, and supplies and perform the labor required to complete the furnishing and installation of, including instrumentation

signal and power conduit and wiring not specifically shown on the electrical drawings, validation, start-up and operational testing of a complete and operable ICM system as indicated on the Drawings and as specified herein.

- e. Provide the equipment components, interconnections and the services of the manufacturers' engineering representatives for the engineering, implementation, startup, operation, and instruction, to insure that the City receives an integrated and operational ICM system as herein specified.
 - f. Coordinate with the requirements of Division 16 and provide for automatic restart of all equipment on restoration of loss-of-power condition. Sequence automatically equipment restart and provide for time delays as necessary to prevent breaker trips on inrush from multiple equipment concurrent starting.
2. As a minimum, the Instrumentation Subcontractor or vendor shall perform the following work:
- a. Implementation of the ICM system:
 - 1) prepare the test plan, the training plan, and the spare parts submittals
 - 2) procure hardware
 - 3) program the ICM system as shown on the Drawings
 - 4) perform bench calibration and verify calibration after installation
 - 5) oversee and certify installation
 - 6) oversee, document, and certify loop testing
 - 7) oversee, document, and certify system commissioning
 - 8) conduct the performance test
 - 9) prepare operations and maintenance manuals
 - 10) conduct training classes
 - 11) prepare record drawings
 - 12) prepare calibration sheets
 - 13) certify the installation of the ICM system
 - 14) provide hardware and software I/O verified checklists
 - b. Integration of the ICM system with instrumentation and control devices being provided under other Sections:
 - 1) Develop all requisite loop drawings and record loop drawings associated with equipment provided under other Divisions.
 - 2) Resolve signal, power, or functional incompatibilities between the ICM system and interfacing devices.

3. Work Not Included

- a. Process piping, installation of in-line instrumentation, i.e., final control elements in process pipelines, air compressors, main air supply headers, and mechanical work as specified in other Divisions.
- b. Electrical power distribution specifically included under Division 16, circuit protection devices, power conduit and wiring indicated, local equipment control stations, and miscellaneous electrical requirements as specified in Division 16.

B. System Responsibility

1. The ICM system as specified in this Division is an integrated system and therefore shall be provided by a competent, qualified CSI who shall have total responsibility for the work of this Division. Entire system installation including calibration, validation, start-up, operational testing, and training shall be performed by qualified personnel, possessing all the necessary equipment and who have had experience performing similar installations. The System shall be integrated using the CSI's latest, most modern proven design and shall, as far as practical, be of one manufacturer.
2. The Contractor shall subcontract the work under this Division to a qualified CSI who shall perform said work but it shall be understood that this shall not relieve the Contractor from any responsibility under the Contractor.
3. The Contractor shall be responsible for the correct installation of all hardware and systems specified in this Division.
4. The Contractor shall be responsible to see that all components of the instrumentation system, including primary measuring, indicating, transmitting, receiving, recording, totalizing, controlling, alarming devices and appurtenances are compatible and shall function as outlined, and he shall furnish and install such additional equipment, accessories and appurtenances as are necessary to meet these objectives at no additional cost to the City.
5. The Contractor shall use the instrument tag and equipment numbering scheme as shown on Contractor Documents, for identifying components which are part of this system.
6. Due to the complexities associated with the interfacing of numerous control system devices, the CSI or vendor shall be responsible to the Contractor for the integration of the ICM system with existing devices and devices provided under other Sections and provide a completely – integrated control system free of signal incompatibilities; this includes providing review and comment to other vendor equipment submittals and overall coordination of the system.

C. Certification of Intent:

1. Fifteen days after notice to proceed, the Contractor shall submit a certification from the selected CSI or vendor. The certification shall be typed on letterhead paper of the CSI or vendor firm. The certification shall be signed by an authorized representative of the CSI or vendor. The certification shall include the following statements:
 - a. (Contractor name) "hereby certifies intent to assume and execute full responsibility to the Contractor to perform all tasks defined under Specification 13000, Section 1.01 Scope, in full compliance with the requirements of the Contractor Documents."
 - b. "It is certified that the quotation to the Contractor includes full and complete compliance with the requirements of the Contractor Documents without exception."

D. Documentation of Instrumentation Subcontractor Qualifications:

1. List of at least two instrumentation and control system projects successfully completed, of size and scope similar to that described herein, in which the applicant performed system engineering, system fabrication and installation, documentation (including schematic, wiring and panel assembly drawings), field testing, calibration and start-up, operator instruction and maintenance training. Each of the references cited must be accompanied by

- a written confirmation of the accuracy of the data by a managerial member of the control system operational staff.
2. In addition, list the following information for each project above:
 - a. Name of plant, City, contact name and telephone number. All phone numbers and contacts shall be verified by the applicant before submission.
 - b. Name of manufacturer(s) for the majority of instrumentation provided.
 - c. Type of equipment furnished (i.e., transmitters, recorders, indicators, etc.)
 - d. Manufacturer and model number of DCS, SCADA, or PLC to which the system interfaced.
 - e. Date of completion or acceptance.
 3. Furnish the name of the individual person who will be responsible for engineering and management of this project, and the individual who will be responsible for field testing, calibration, start-up, and operator training for this project. Include references of recent projects of these individual persons.
 4. Submit specific documentation which verifies that CSI employs the minimum of individuals who have been formally trained in the application of the:
 - a. Indicated operating systems.
 - b. Indicated software packages.
 - c. Indicated graphical user interface software packages.
 5. Document that the applicant's company has been actively involved in the instrumentation systems business (under the same corporate name).

E. Contractor Drawings

1. Information on the Drawings
 - a. The following information relative to the work of this Division is indicated on the Contractor Drawings.
 - 1) Location of primary elements, control panels, and final control elements.
 - 2) Instrumentation signal and power conduit runs between control panels and field instruments and devices.
 - 3) Quantity and sizes of instrumentation conductors and cables are indicated on the drawings, but shall be verified by the Contractor.
 - 4) Location of all equipment having alarm and equipment status contacts.
 - 5) Major instrument conduit runs.
 - 6) General control room layout
2. Information Not on the Drawings
 - a. The following information relative to the work of this Division may not be shown on the Drawings, but shall be the responsibility of the Contractor to determine, furnish, coordinate with other Trades, and submit for approval, based upon the systems specified.

- 1) Tubing for pneumatic signals, and/or power between main headers and control panels, field mounted primary elements, field instruments and final control elements.
- 2) Number or sizes of tubing required for pneumatic and hydraulic signals.
- 3) Point of connection to any hydraulic or pneumatic supply lines.

1.02 STANDARDS

A. American National Standards Institute (ANSI)

1. ANSI/ISA-S5.1-1984 (R1992)

B. National Fire Protection Association (NFPA)

1. NFPA 70 National Electric Code (NEC)

1.03 SUBMITTALS

A. General.

Refer to the Design Documents for required method of preparation and transmittal and conform to requirements herein.

1. Pre-submittal Conference

- a. Arrange a conference with CSI, the City Engineer, and the City within thirty (30) days after award of the Contractor for the purpose of informally discussing in detail and verifying the correctness of the CSI's system engineering methods and equipment and to generally provide a framework for communication and coordination. This conference shall be attended by CSI, and duly authorized representatives of the Contractor and City.
- b. Submit 4 copies of the following items for discussion at the Pre-submittal Conference:
 - 1) A list of equipment and materials required for the ICM system and the manufacturer's name and model number for each proposed item. Identify items by P&ID tag number, description, function, manufacturer, model number, descriptive literature and statement as to whether item is "as specified" or "equivalent." Items identified as "equivalent" shall be accompanied by a comparative listing and only be accepted by the City if the specified item is no longer manufactured.
 - 2) A list of proposed clarifications to the Contractor Documents along with a brief explanation of each. Resolution shall be subject to a separate formal submittal and review by the City Engineer.
 - 3) A sample of each type of submittal specified herein.
 - 4) A flow chart showing the steps to be taken in preparing and coordinating each submittal.

- 5) A bar-chart type schedule for all system related activities from the Pre-submittal Conference through start-up and training. Dates of submittals, design fabrication, programming, factory testing, deliveries, installation, field testing, and training shall be shown. The schedule shall be subdivided to show activities relative to each major item or group of items when everything in a given group is on the same schedule.
 - 6) An overview of the proposed training plan. The City Engineer will review the overview and may request changes. All changes to the proposed training shall be resolved at the Pre-submittal Conference. The overview shall include the following for each proposed course:
 - a) Course title and objectives.
 - b) Prerequisite training and experience of attendees
 - c) Course content – a topical outline.
 - d) Course duration
 - e) Course format – lecture, laboratory demonstration, etc.
 - 7) A preliminary copy of the Instrumentation Subcontractor Qualification submittal.
- c. Take minutes of the Pre-submittal Conference, including all events, questions, and resolutions. Before adjournment, all parties must concur with the accuracy of the minutes and sign accordingly.

B. Shop Drawings

Before proceeding with any manufacturing, submit Shop Drawings for approval in complete bound sets indexed by specification number. Describe the items being submitted. Manufacturer's specification or data sheets shall be clearly marked to delineate the options or styles to be furnished. Submit only complete systems, not pieces of equipment from various systems. Show dimensions, physical configurations, methods of connecting instruments together, mounting details, and wiring details, and wiring schematics. Schematics shall be complete with tag and terminal numbers. Submit fabrication drawings, nameplate legends, and control panel internal wiring and piping schematic drawings clearly showing equipment and tag numbers on panels. Submit panel graphic drawings where applicable. Include material specifications lists where applicable. Include a draft of the theory of operation for relay logic circuits including those implemented via programmable controllers. Submit detailed field instrument installation drawings for each instrument.

C. Design Related Submittals

1. In accordance with the requirements of Division 1, provide the following submittals (where applicable):
 - a. Catalog Cuts
 - 1) Catalog information, descriptive literature, wiring diagrams, and shop drawings shall be provided for all devices, whether electrical or mechanical, furnished under this Section. This includes, but is not limited to, primary elements,

transmitters, analytical equipment, gauges, valves, controllers, indicators, power supplies, switches, lights, relays, timers, etc.

2. Component Data Sheets

- a. Data sheets, specification sheets, and an instrument list shall be provided for components provided under this Section. The purpose of this material is to supplement the generalized catalog information by providing the specifics of each component (e.g., part numbers, scales, ranges, service, materials of construction, component location, options, and the individual tag number as noted in the Drawings and Specifications.
- b. Include such other necessary data as would provide a complete and adequate specification for reordering an exact duplicate of the original item from the manufacturer at some future date. Each tag numbered item shall be included on a separate sheet.

3. Sizing Calculations

- a. Complete sizing calculations shall be provided for all flow elements. The calculations shall include the process data used, minimum and maximum values, permanent head loss and all assumptions made. Equations shall be submitted for all computing modules and function generating modules and shall include the actual scaling factors and units used.

4. ~~Panel Construction Drawings~~

a. ~~Shop Drawings and Catalog Cuts~~

- ~~1) Provide detailed shop drawings and catalog cuts for panels, instrument racks, and enclosures. Drawings shall show the location of front panel and internal sub-panel mounted devices to scale and shall include a panel legend and bill of materials. Layout drawings shall show major dimensions as well as elevations, in inches from the base up, of the rows of components.~~
- ~~2) Shop drawings shall indicate location and size of available spare mounting space for rear of panel devices. See Section 13200 - Control Panels.~~
- ~~3) The panel legend shall list and identify front of panel devices by their assigned tag numbers, nameplate inscriptions, service legends, and annunciator inscriptions.~~
- ~~4) The bill of materials shall include devices mounted within the panel that are not listed in the panel legend, and shall include the device tag number, description, manufacturer, and complete model number.~~

b. ~~Color Schedule~~

- ~~1) Provide a color schedule with color samples for control panels for the City's selection/approval.~~

5. ~~Power Requirement and Heat Dissipation~~

- a. ~~Provide a summary of the power requirements and heat dissipation for control panels. Power requirements shall state required voltages, currents, and phase(s). Heat dissipations shall be maximums and shall be given in BTU/Hr. Summary shall be supplemented with calculations.~~

6. Panel Wiring Diagrams

- a. Wiring diagrams shall be similar to those diagrams shown in the Contractor Drawings, but with the addition of all auxiliary devices such as additional relays, alarms, fuses, lights, hand switches and interlocks.
- b. Provide complete terminal identification of external primary elements, panels, and junction boxes that interface directly to the panel wiring being shown. Polarity of analog signals shall be shown at each terminal.
- c. External wiring that the electrical contractor must provide and wire shall be shown as a dotted line. Special cables that are provided with the instrument shall be clearly identified.
- d. Panel wiring diagrams shall identify wire numbers and types, terminal numbers, and tag numbers. Wiring diagrams shall show each circuit individually. Common or typical diagrams shall not be allowed.
- e. Provide panel power wiring diagrams for panels. The diagrams shall include grounding requirements.

7. Interconnecting Wiring Diagrams

- a. Diagrams shall show component and terminal board identification numbers, external wire and cable numbers. The drawings shall show intermediate terminations between field elements and panels (e.g., terminal junction boxes). This diagram shall be coordinated with the Contractor and shall bear his mark showing that this has been done.

8. Loop Diagrams

- a. Provide an individual wiring diagram for each analog loop showing terminal numbers, the location of the DC power supply, the location of any dropping resistors, the location and connection of the surge protection devices. The loop diagrams shall meet the minimum requirements of ISA S5.4 plus the following requirements:
- b. Each loop diagram shall be divided into three areas for identification of device locations: panel face, back-of-panel, and field respectively. Each loop diagram shall list (1) Transmitter Drive Capability, (2) Loop Impedance, (3) Transmitter Reserve Drive Capability. Loop diagrams shall be on 11-inch by 17-inch Drawings.

9. Instrument Installation Details

- a. The CSI shall review the Contractor Documents and develop and submit for review, complete installation details for each field mounted device and panel prior to shipment and installation. Common details, not requiring any modification, may be referenced by an index showing the complete instrument tag number, service, location, and device

description. Installation details shall be provided as required to adequately define the installation of the ICM system components.

10. Operator Interface Submittal

- a. This submittal shall cover the specific plant control schemes as well as the details of the plant reports and process graphic displays.
- b. The submittal shall contain the semi-final details of all logs, reports, and process graphic displays. The specifics of what shall appear on each display and what calculations are required to support them shall be developed and submitted.
- c. Submitted process graphic displays shall be no smaller than 8.5 inches by 11 inches and in full color.
- d. A complete listing of all signals to be collected for long term historical information shall be provided.
- e. A complete listing of all signals to be collected for trend display shall be provided. This listing shall also include frequency of data sampling and duration for which the data shall be immediately accessible. A complete listing of all signals to be collected for trend display shall be provided. This listing shall also include frequency of data sampling and duration for which the data shall be immediately accessible.

11. Process Control Strategy Submittal:

- a. The process control schemes shall be developed in a ladder logic diagram or functional block (logic) diagram presentation based on information from the Specifications. Included with each diagram shall be:
 - 1) Brief Scope of the Control Function.
 - 2) Listing of all scanned inputs to the control function.
 - 3) A short narrative of the control strategy
 - 4) Any assumptions made in developing the program
 - 5) Listing of all inputs and outputs (i.e., AI, DI, AO, DO) from the control function.
 - 6) Cross reference list of all I/O showing to which I/O modules or software modules they are linked.
 - 7) Listing of all operator inputs/outputs to and from the control function. Any special CRT displays related to the function shall be illustrated. A description of the operation of any panels shall be described as it relates to the control function.
 - 8) Failure contingencies shall be described in detail.
 - 9) A flowchart representing the control strategy.
- b. This submittal shall cover all of the associated logic developed under this Contractor required to implement the control functions specified.
- c. The System Integrator shall submit annotated logic on 8-1/2 x 11" format and as an ASCII file on compact diskettes for all logic developed. Annotation shall be 3 lines of 6 characters each for every logic contact. In addition, each network or rung shall be annotated so that a non-technical person can read and easily comprehend what control function the rung or network is performing.
- d. This submittal shall also include copies of the PLC I/O configuration tables, I/O reference usage table, complete cross reference to specific rung used of all inputs, outputs, internal coils, data registers, and special purpose coils. In addition, any special

switch settings or hardware configuration requirements such as component configurations shall be described in detail and submitted.

D. Test Related Submittals

Provide five (5) copies of the following:

1. Operational Field Acceptance Test (OAT) Documentation

The CSI shall submit an example of each type of Instrument Calibration Sheet and Loop Status Report that will be used for the OAT.

After approval of the examples, the CSI shall prepare Loop Status Report Sheet(s) for each loop and an Instrument Calibration Sheet for each active ICM system element (except simple hand switches, lights, etc.) These sheets shall be submitted after the tests are completed.

a. Instrument Calibration Sheets

- 1) Provide a written report to the City Engineer on each instrument certifying that it has been calibrated to its published specified accuracy. This report shall include all applicable data as listed below plus any defects noted, correction action required, and correction made. Data shall be recorded on prepared forms and shall include not less than the following items:

- a) Facility identification (Name, location, etc.)
- b) Loop identification (Name or function)
- c) Equipment tag and serial numbers.
- d) Scale Ranges and units.
- e) Test mode or type of test.
- f) Input values or settings.
- g) Expected outputs and tolerances
- h) Actual readings at 10, 50, and 90 percent of span.
- i) Explanations or special notes as applicable.
- j) Date, time, and weather.
- k) Tester's certification with name and signature.

2. Functional Acceptance Test Documentation.

The CSI shall prepare two types of test procedures and forms as follows.

a. Loop Test Documentation

For functions that can be demonstrated on a loop-by-loop basis, the form shall include:

- 1) Project Name.
- 2) Loop number.
- 3) Loop description.

- 4) Test procedure description, with a space after each specific test to facilitate sign off on completion of each test.
- 5) For each component: tag number, description, manufacturer, and data sheet number.
- 6) Space for sign off and date by the ICM, the Contractor and the City Engineer.

b. Functional Test Documentation

For those functions that cannot be demonstrated on a loop-by-loop basis, the test form shall be a listing of the specific tests to be conducted. With each test description the following information shall be included:

- 1) Specification page and paragraph of function demonstrated
- 2) Description of Function
- 3) Test procedure description
- 4) Space after each specific test to facilitate signoff on completion of each test.

E. Testing

1. ~~Factory Testing~~

a. ~~Unwitnessed Factory Testing. Prior to the arrival of the City and/or City Engineer, each panel shall have been completely tested by the manufacturers personnel. Provide report certifying the control panels are operable and meet the Specifications. If upon arrival at the City and/or City Engineer, the panel(s) tests have not been performed, the Contractor shall be liable for back charges for extra time required for the City and/or City Engineer's services. The necessary panel tests shall be repeated in the presence of the City Engineer; the City Engineer shall have the right to check all test observations. The CSI shall demonstrate, on a spot check basis, that the results of the unwitnessed Factory Tests are accurate. As a minimum, tests shall verify the following:~~

- ~~1) Accuracy of panel instruments for 4-20 mA inputs and outputs.~~
- ~~2) Location of interface wires on terminal blocks.~~
- ~~3) Function of discrete panel components~~

b. ~~Witnessed Factory Testing. Inspection and test of materials and equipment shall be made by the City and City Engineer (or his representative) at the place of manufacturer prior to shipment, to verify that the completed control panel(s) meets the requirements of the specifications. Shipment shall not be made until receipt of written approval from the City Engineer after satisfactory completion of shop tests.~~

c. ~~The manufacturer furnishing materials, equipment and labor for the fabrication of the panel(s) shall afford the necessary facilities for such shop inspection and tests. The Contractor shall give the City and/or City Engineer written notice three (3) weeks prior to the estimated date when the equipment will be ready for the inspection and witnessed shop test.~~

d. ~~Sufficient time, ample space and necessary assistance shall be provided by the manufacturer to assure inspection and testing to the satisfaction of the City Engineer.~~

- e. ~~The CSI shall furnish the power, labor, materials, and properly calibrated instruments required for the shop tests.~~
- f. ~~The City Engineer reserves the right to reject defective materials, poor workmanship and items that are not in accordance with the requirements of the specifications.~~

2. Operational Field Acceptance Testing

a. Installation Supervision

- 1) Furnish the services of authorized factory personnel specially trained and experienced in the installation of the equipment to: (1) supervise the installation in accordance with the approved Instruction Manual; (2) be present when the instruments and equipment are first put into operation; (3) inspect, check, adjust as necessary, and approve the installation; (4) calibrate the instruments, in accordance with the with the Specifications herein, until all trouble or defects are corrected and the installation and operation are acceptable.

b. Instrument Calibration

- 1) Provide the services of factory trained instrumentation technicians, tools and equipment to field calibrate each instrument to its specified accuracy in accordance with the manufacturer's specifications and instructions for calibration. Each instrument shall be calibrated at 10 percent, 50 percent and 90 percent of span using test instruments to simulate inputs and read outputs that are rated to an accuracy of at least 10 times greater than the specified accuracy of the instrument being calibrated.
- 2) Provide a list and basic specifications for instruments used for calibration.

c. System Validation

- 1) Provide the services of factory trained and field experienced instrumentation engineer(s) to validate each system to verify that each system is operational and performing its intended function within system tolerance. System tolerance is defined as the root-mean-square sum of the system component published specified accuracies from input to output.
- 2) Validate the system by simulating inputs at the first element in each loop of 10 percent, 50 percent and 90 percent of span, or on/off and verifying loop output devices (i.e. recorder, indicator, alarm, except controllers) During system validation, make provisional settings on levels, and alarms. Verify controllers by observing that the final control element moves in the proper direction to correct the process variable as compared to the set point. Verify that logic sequences operate in accordance with the specifications.
- 3) Cause malfunctions to sound alarms and/or switch to standby to check system operation. Check systems thoroughly for correct operation. Test equipment for this function shall be as specified under "Instrument Calibration." Demonstrate recovery to loss of power.
- 4) Immediately correct defects and malfunctions disclosed by tests. Use new parts and materials as required and approved and retest.

- 5) Provide a report certifying completion of validation of each instrument system. This report shall indicate calculated system tolerances, data verifying that the system meets these tolerances, and any provisional settings made to devices. Data sheets shall be similar to those used for calibration.

d. Contractor's Certified Reports

- 1) Upon completion of all testing, the CSI, or its authorized representative, shall submit a certified report for each control panel and associated field instruments certifying that the equipment (1) had been properly installed under its supervision, (2) is in accurate calibration, (3) was placed in operation in his presence, (4) has been checked, inspected, calibrated, and adjusted as necessary, (5) has been operated under maximum power variation conditions and operated satisfactorily, and (6) is fully covered under the terms of the guarantee.

3. Final Acceptance Testing

- a. Upon completion of instrument calibration and system validation, test systems under actual process conditions in the presence of the City Engineer. The intent of this test is to demonstrate and verify the operational interrelationship of the instrumentation systems. This testing shall include, but not be limited to, specified operational modes, taking process variables to their limits (simulated or process) to verify alarms, failure interlocks, interlocks, and operational interlocks between systems and/or mechanical equipment.
- b. Testing shall be observed by the City and/or City Engineer. Notify the City and/or City Engineer in writing a minimum of 48 hours prior to the proposed date for commencing the test. Upon completion of this test the Contractor shall begin or have begun system start-up. City and/or City Engineer reserves the right to set the schedule.
- c. Submit for approval not later than 30 days prior to the final acceptance test demonstration, a written plan for demonstrating that each system of equipment provided under Division 13 meets the specified operational requirements.
- d. The plan shall detail procedures to be used in final acceptance testing of applicable systems. The plan shall include a description of test methods and materials utilized for testing each system.
- e. Immediately correct defects and malfunctions with approved methods and materials in each case and repeat the testing.
- f. Submit three copies of test results and records for all final acceptance tests.
- g. Upon completion of final acceptance testing, submit certified report, with substantiating data sheets, indicating that total ICM System meets all the functional requirements specified herein. The City and/or City Engineer will countersign this report and it shall constitute final acceptance of the ICM System.

4. System Commissioning Assistance

- a. Provide the services of a factory trained and field experienced instrumentation engineer to assist City's personnel during each startup of the various systems. Purpose of this assistance is to support in making final adjustments of settings on the instrument systems.

F. Operation & Maintenance Manuals.

Furnish Instruction Manuals and Parts Lists for instrumentation equipment in accordance with the requirements of Division 1 and as noted herein.

1. Schedule

- a. Deliver manuals not later than the equipment shipment date. After installation is complete, update the manuals to reflect any changes which occurred during installation and deliver balance of manuals to City Engineer.

2. Material Content. Include in the manuals not less than the following applicable information for each instrument, equipment, subsystem and/or control loop. The O&M Manuals shall consist of, at least, the following material:

a. Bill of Materials

- 1) A listing of all the panels, racks, instruments, components, and devices supplied.

Components shall be grouped by component type, with the component types identified in a similar manner to the component identification code used in these specifications. The list shall contain, as a minimum:

- a) Instrument, panel, rack or device tag number
- b) Description
- c) Quantity supplied
- d) Reference to component data sheet and/or catalog cut
- e) Component type

b. Component Data Sheets

- 1) See 1.02 B.2 specified herein before.

c. Catalog Cuts

- 1) See 1.02 B.1 specified herein before.

d. Component O&M Manuals

- 1) An O&M manual shall be submitted for instruments and devices supplied. The O&M manuals shall contain, as a minimum:

- a) Operating procedures
- b) Installation procedures
- c) Maintenance procedures
- d) Troubleshooting procedures
- e) Calibration procedures
- f) Internal device schematics and wiring diagrams
- g) Shut-down procedures

- h) Component parts list
 - i) Detailed circuit operational description including annotated programmable controller ladder diagrams.
- e. Spare Parts and Expendables List
 - 1) The spare parts and expendables list shall include not only those items supplied, but also the additional items recommended for successful long term operation.
- f. "As-Shipped" Drawings
 - 1) Drawings shall be a record of work "As-Shipped" from the factory and shall be labeled as "As-Shipped". One copy of applicable schematics and diagrams shall be placed in each control panel in a protective envelope or binder. Provide the following "As-Shipped" drawings as a minimum:
 - a) Panel Fabrication Drawings.
 - b) Panel Wiring and Interconnection Drawings.

G. Final Record Documentation's

1. Reproducible Drawings. Contractor shall submit reproducible's of finished schematics, wiring diagrams and installation drawings to include installed field and panel instruments, mounting details, point to point diagrams with a cable, wire, and termination numbers. Drawings shall be a record of work as actually constructed and shall be labeled as "RECORD DOCUMENTS." One copy of applicable schematics and diagrams shall be placed in each control panel in a protective envelope or binder.
 - a. Loop Diagrams
 - 1) See 1.02 B.8 specified herein before.
 - b. Panel Fabrication and Wiring diagrams
 - 1) See 1.02 B.4 and 1.02 B.6 specified herein before.
 - c. Interconnecting Wiring Diagrams
 - 1) See 1.02 B.7 specified herein before.
 - d. Instrument Installation Details
 - 1) See 1.02 B.9 herein before.
2. Process and Instrumentation Diagrams (P&ID's)
 - a. The City Engineer will supply the Contractor with P&ID's on magnetic media for revisions to reflect the final installed system.

- b. The P&ID's shall be updated by the Contractor who may use these drawings for producing the final documentation.
- 3. Software Documentation. In addition to the reproducible hard copy of drawings and literature generated specifically for the project, Contractor shall submit CD-ROM's to the City Engineer with a copy of all custom files specifically created to generate the drawings, data sheets, bill of materials, operating procedures etc. Drawing format shall be compatible with AutoCad ver. 2009 or newer. Disks shall be clearly identified by the following:
 - a. Project Name
 - b. Volume Number
 - c. Software Program Name and Version used to generate the files.
 - d. Labeled "RECORD DOCUMENTS"

H. Training Requirements

- 1. General:
 - a. Provide the services of a factory trained and field experienced instrumentation engineer to conduct group training of City's designated personnel in the operation of each instrument system. Obtain City's written consent that the training has been adequate. Include instruction covering basic system theory, operating principles and adjustments, routine maintenance and repair, and "hands on" operation. The text for this training shall be the P & ID's, graphic operation interface, PLC and SCADA software, panel wiring diagrams and layouts, and the operation and maintenance manuals furnished under these Specifications.
- 2. Duration:
 - a. Training specific to the system control panel hardware and software. This training shall be for a minimum time period of 30 8-hour days and 6 trips. This training shall be separate from start-up and testing. See Section 01664 – Training.
- 3. Operator Training:
 - a. Operator training shall include instruction in the use of Control Panels and Field Panels furnished.
- 4. Maintenance Training:
 - a. Maintenance training shall include instruction in the calibration, maintenance, and repair required for all instruments.

I. Post- Contractor System Support

- 1. Maintenance Contractor:
 - a. Duration

- 1) Provide a 1 year maintenance contract for components furnished starting from the date of acceptance.

b. Schedule

- 1) Develop a program of preventive maintenance visits that includes verification of instrument performance on a monthly basis and complete calibration of instruments on a semi-annual basis. After every visit, submit to the City records of instrument verification and calibration on appropriate forms.

J. Guarantee and Warranties

1. Guarantee the work of Division 13 in accordance with the Conditions of Contractor and Division 1. With respect to instruments and equipment, guarantee shall cover (a) faulty or inadequate design; (b) improper assembly or erection; (c) defective workmanship or materials; and (d) leakage, breakage, or other failure not caused by City misuse. For equipment bearing a manufacturer's warranty in excess of one year, furnish a copy of the warranty to City Engineer with City named as beneficiary.

PART 2 - PRODUCTS

2.01 HARDWARE REQUIREMENTS

A. Job Conditions

1. Drawings are diagrammatic and show the intended arrangement for system operation, piping, and appurtenances. Conform to Drawings as closely as possible and exercise care (1) to secure neat arrangement of piping, valves, conduit, and like items, and (2) to accommodate structural features. Verify dimensions and conditions at the place of work, and install materials and equipment in the available spaces.

~~B. Materials and Standard Specifications~~

- ~~1. Provide instruments, equipment and materials suitable for service conditions and meeting standard specifications such as Instrument Society of America (ISA). The intent of this Specification is to secure instruments and equipment of a uniform quality and manufacture throughout the facilities; instruments supplied by the Contractor, of the same type shall be by the same manufacturer. All panel mounted instruments shall have matching style and general appearance. All meters, instruments, and other components shall be the most recent field-proven models marketed by their manufacturers at the time of submittal of the shop drawings unless otherwise required to match existing equipment. This allows the stocking of the minimum number of spare parts.~~

C. Product Delivery, Storage, and Handling at project site

1. Box, crate, or otherwise enclose and protect instruments and equipment during shipment, handling, and storage. Keep all equipment dry and covered from exposure to weather, moisture, corrosive liquids and gases or any element which could degrade the

equipment. Protect painted surfaces against impact, abrasion, discoloration, and other damage. Repair any damage as directed and approved.

D. Mountings

1. Mount and install equipment as indicated. Where not shown, mount field instruments according to best standard practice on pipe mounts, pedestal mounts, or other similar means in accordance with suppliers recommendation. Unless specified otherwise all mounting hardware shall be stainless steel. Where mounted in control panels, mount according to manufacturer recommendations.
2. Equipment specified for field mounting shall be suitable for direct pipe mounting, pedestal mounting, or surface mounting. Non in-line indicators and equipment with calibration adjustments or requiring periodic inspection shall be mounted not lower than three (3) feet nor higher than five (5) feet above walkways, platforms, and catwalks. Such equipment shall be weather and splash proof, and corrosion resistant and electrical equipment shall be in 316SS NEMA 4X cases unless otherwise noted.

E. Instrument Identification

1. Components provided under this Section, both field and panel mounted, shall be provided with permanently mounted name tags bearing the entire ISA tag number of the component. Panel mounted tags shall be plastic; field mounted tags shall be stamped stainless steel.
2. Nameplates for panels and panel mounted equipment shall be as specified under Section 13200 – Control Panels.
3. Field mounted tags shall be 16-gauge, 304 stainless steel with 3/16 inch high characters.
4. Tags shall be attached to equipment with a commercial tag holder using a stainless steel band with a worm screw clamping device or by a holder fabricated with standard stainless steel hose clamps and meeting the same description. In some cases where this would be impractical, use 20 gage stainless steel wire.
5. For field panels or large equipment cases use stainless steel screws, however, such permanent attachment shall not be on an ordinarily replaceable part. In each case, the tag shall be plainly visible to a standing observer and not obscure adjustment ports or impair the function of the instrument. Field mounted control stations, recorders or indicators shall have a nameplate indicating their function and the variable controlled or displayed. Nameplate shall be attached by one of the above methods.

F. Electronic Equipment

1. If the equipment is electronic in nature, provide solid state equipment to the greatest extent practicable. Select components of construction for their suitability and reliability. Employ adequate component derating to preclude failures because of transients and momentary overloads reasonably expected in normal operation. Where conduit connection is provided for mounting a surge/lightning suppresser directly to the instrument, the arrestor shall be so mounted.

G. Equipment Operating Conditions

1. Equipment shall be rated for normal operating performance with varying operating conditions over the following minimum ranges:

2. Power:

- a. Electrical. 115 VAC +/- 10%, 60 Hz +/-1 Hz except where specifically stated otherwise on the drawings or in the specifications.

3. Field Instruments:

a. Atmospheric contaminants (All Areas):

- 1) Hydrogen Sulfide: 0.1 mg/l
- 2) Chlorine: 0.01 mg/l
- 3) Ammonia: 0.5 mg/l
- 4) Dust: 50.0 µg/m³

b. Outdoor Areas:

- 1) Ambient Temperature: -20°F to +120°F
- 2) Ambient Relative Humidity: 10% to 95%
- 3) Weather: Rain, wind, sun and blowing sand.

4. Indoor Environmentally Uncontrolled Areas:

- a. Ambient Temperature: 40°F to +105°F
- b. Ambient Relative Humidity: 20% to 80%

5. Indoor Environmentally Controlled Areas:

- a. Ambient Temperature: 55°F to +85°F
- b. Ambient Relative Humidity: 20% to 80%
- c. Short term excursions to temperature limits for non-environmental controlled areas.

- 6. Provide, as necessary, enclosures, heat tracing, heaters and sunshields, etc. to assure normal operations under these conditions.
- 7. Corrosive Areas: Provide instrument enclosures and hardware suitable for the corrosive location.
- 8. Hazardous Areas: All equipment used in areas designated as hazardous shall be designed for the Class, Group, and Division as required on the Electrical Drawings for the locations. All work shall be in strict accordance with codes and local rulings, should any work be performed contrary to said rulings, ordinances and regulations, the Supplier shall bear full responsibility for such violations and assume all costs arising there from

H. Power Supplies

- 1. Provide electrical instruments and control devices for operation on 120 VAC, 60 Hz current.
- 2. Unless otherwise indicated provide battery backed up Uninterruptable Power Supply (UPS) with AC inversion for each control panel and PLC. UPS shall be sized to run the peak tributary load for a period of not less than 30 minutes. UPS shall be mounted in the respective panel. Minimum UPS size shall be 500 watt-hour. Provide bypass switch for

panels to run directly from power source or through UPS with front of panel mounted indicator light showing current modes.

3. Output overvoltage and overcurrent protective devices shall be provided for DC power supplies to protect instruments from damage due to power supply failure and to power supply from damage due to external failure. Power supplies shall be provided with NEMA 1 enclosures. Power supplies shall be mounted such that dissipated heat does not adversely affect other components. Source of operating power shall be 120 VAC, 60 Hz commercial power. Units shall be mounted within the control panels. Power supply fusing shall be provided with blown fuse indicators.

I. Signal Isolators, Converters and Conditioners

1. Insure that input-output signals of all instruments and control devices (new and existing) are compatible. Analog signals between field and panels shall be Profibus unless specifically approved otherwise. Granting such approval does not relieve the Contractor from the compatibility requirement above. Provide signal isolators and converters as necessary to obtain the required system performance. Mount the devices behind control panels or in the field at point of application, as required for accurate signal acquisition.

J. Auxiliary Contacts by Others

1. Provide instruments and equipment to connect to auxiliary contacts provided by others for alarms, status of equipment, interlocking, and other functions as indicated and as specified herein.

K. Painting

1. Provide factory paint for instruments and equipment except where in pipelines. Provide paint as required in Division 9 for non-stainless steel structural supports, brackets, etc.

L. Electrical

1. Work shall include the power supply wiring, instrumentation wiring, interconnecting wiring and equipment grounding as indicated, specified and required and not specifically included under Division 16.
2. Wiring installations shall include cables, conductors, terminals, connectors, wire markers, conduits, conduit fittings, supports, hardware and all other required materials not specifically included in the work of other Divisions.
3. Provide the materials and complete the required installations for equipment grounding as specified in Division 16 of these Specifications and indicated on the Electrical Drawings.
4. Incidental items not specifically included in the Contractor Documents that can legitimately and reasonably be inferred to belong in the instrumentation work shall be provided and installed by the Contractor at no additional cost to the City.
5. Field Wiring. For wiring materials, refer to Division 16 and Details on the Electrical Drawings. Test signal wiring for continuity prior to termination. Provide wire number tags marked in indelible waterproof form of slip-on type heat shrink label or equal for each termination.

M. Process Connections

1. Provide instrument piping, tubing, and capillary tubing to meet the intended process service and ambient environmental condition for corrosion resistance, etc. All instrument pneumatic tubing shall be 316 SS. Slope lines according to service to promote self draining or venting back to the process. Terminate connection to process lines or vessels in a service rated block valve that will permit closing off the sense line or removal of the element without requiring shut down of the process. Include drip legs and blow-down valves for terminations of sense lines at the instruments when mounted such that condensation can accumulate. Process vessels, line penetrations, connecting fittings, and block valves shall be furnished and installed under other Divisions of these Specifications but coordinated by this Division.

N. Spares and Maintenance Materials

1. Furnish the following items as specified herein. Deliver to City Engineer, as directed, with itemized list in a letter of transmittal accompanying each shipment.
2. Materials shall be delivered in the manufacturer's original containers labeled to completely describe contents and equipment for which it is furnished.
3. One Fuse of each size and type for every five used but no less than five of each type.
4. One Relay of each type for every five used but no less than two of each type.
5. One Panel Indicating Light Bulb for every five used but no less than four of each type.
6. One PLC I/O and communication card of each type.
7. One Transient Protector for every five used but no less than four of each type.

PART 3 - EXECUTION

3.01 PRODUCT HANDLING

- A. Shipping Precautions: After completion of shop assembly, factory test, and approval, all equipment, cabinets, panels, and consoles shall be packed in protective crates and enclosed in heavy duty polyethylene envelopes or secured sheeting to provide complete protection from damage, dust, and moisture. Dehumidifiers shall be placed inside the polyethylene coverings. The equipment shall then be skid-mounted for final transport. Lifting rings shall be provided for moving without removing protective covering. Boxed weight shall be shown on shipping tags together with instructions for unloading, transporting, storing, and handling at the job site.
- B. Special Instructions: Special instructions for proper field handling, storage, and installation required by the Manufacturer shall be securely attached to each piece of equipment before packaging and shipment.
- C. Tagging: Each component shall be tagged to identify its location, instrument tag number, and function in the system. A permanent stainless steel or other non-corrosive material tag firmly attached and permanently and indelibly marked with the instrument tag number, as given in the tabulation, shall be provided on each piece of equipment in the ICM system. Identification shall be prominently displayed on the outside of the package.

- D. Storage: Equipment shall not be stored outdoors. Equipment shall be stored in dry permanent shelters, including in-line equipment, and shall be adequately protected against mechanical injury. If any apparatus has been damaged, such damage shall be repaired by the Contractor at no additional cost to the City. If any apparatus has been subject to possible damage by water, it shall be thoroughly dried out and put through tests as directed by the City Engineer. Such tests shall be at no additional cost to the City, and if the equipment fails the tests, it shall be replaced at no additional cost to the City.
- E. Protection during Construction: Instrumentation and Controls shall at all times during construction be adequately protected against mechanical injury, water damage, corrosion, dirt, dust and foreign material. Equipment equipped with internal electrical heaters shall have them energized to keep the equipment dry. Doors to control panels and cabinets shall be kept closed at all times when work on them is not being done. Control Panels, Analyzers, sensitive electronic or computer equipment and/or controls or other materials not sealed and/or suitable for continuous outdoors storage shall not be stored out-of-doors. Such Instrumentation and Controls shall be stored in dry permanent shelters.
- F. Paint Finish: Any damage to factory applied paint finish shall be repaired using touch-up paint furnished by the instrument or equipment manufacturer.

3.02 MANUFACTURER'S SERVICES

- A. Furnish the following Manufacturer's services for the instrumentation listed above:
 - 1. Perform bench calibration
 - 2. Oversee installation
 - 3. Verify installation of installed instrument
 - 4. Certify installation and reconfirm Manufacturer's accuracy statement
 - 5. Oversee loop testing, prepare loop validation sheets, and certify loop testing
 - 6. Oversee pre-commissioning, prepare pre-commissioning validation sheets, and certify pre-commissioning
 - 7. Train the City's personnel

3.03 INSTALLATION

- A. General:
 - 1. All instrumentation, including instrumentation furnished under other Divisions, shall be installed per the manufacturers' instructions and Division 13.
 - 2. Equipment Locations: The monitoring and control system configurations indicated are diagrammatic. The locations of equipment are approximate. The exact locations and routing of wiring and cables shall be governed by structural conditions and physical interferences and by the location of electrical terminations on equipment. All equipment shall be located and installed so that it will be readily accessible for operation and maintenance. Where job conditions require reasonable changes in approximated locations and arrangements, or when the City exercises the right to require changes in location of equipment that do not impact material quantities or cause material rework, make such changes without additional cost to the City.

B. Conduit, Cables, and Field Wiring

1. All conduit shall be provided under Division 16.
2. All 4-20 mA signal circuits, process equipment control wiring, signal wiring to field instruments, remote I/O, PLC I/O, and other non-specialty field wiring and cables shall be provided and installed under Division 16.
3. All ICM system specialty cables, data highway fiber optic cable and specialty cable termination devices shall be provided under Division 13 and installed under Division 16.
4. All field cables and wiring terminations and wire identification at ICM system equipment furnished under this or any other Division shall be provided under Division 16. All terminations shall be checked by the equipment supplier and the electrical contractor.

C. Instrumentation Tie-Downs: All instruments, control panels, and equipment shall be anchored by methods that comply with seismic requirements that apply to the site.

D. Existing Instrumentation: Each existing instrument to be removed and reinstalled shall be cleaned, reconditioned and recalibrated by an authorized service facility of the instrument Manufacturer. Provide certification of this Work before reinstallation of each instrument. Provide replacement for interim period as required.

E. Ancillary Devices: The Contractor Documents show all necessary conduit and instruments required to make a complete instrumentation system. The Contractor shall be responsible for providing any additional or different type connections as required by the instruments and specific installation requirements at no additional cost to the City. All such additions and all such changes, including the proposed method of installation, shall be submitted to the City Engineer for approval before commencing the Work. Such changes shall not be a basis of claims for extra work or delay.

F. Installation Criteria and Validation: All field-mounted components and assemblies shall be installed and connected according to the requirements below:

1. Installation personnel have been instructed on installation requirements of the Contractor Documents.
2. Technical assistance is available to installation personnel at least by telephone.
3. Installation personnel have at least one copy of the approved shop drawings and data.
4. Instrument process sensing lines shall be installed similar to conduit specified under Section 16050 - Basic Electrical Materials and Methods. Individual tubes shall run parallel and near the surfaces from which they are supported. Supports shall be used at intervals of not more than 3 feet of rigid tubing.
5. Bends shall be formed to uniform radii with the proper tool without deforming or thinning the walls of the tubing. Plastic clips shall be used to hold individual plastic tubes parallel. Ends of tubing shall be square-cut and cleaned before being inserted in the fittings. Bulkhead fittings shall be provided at all panels requiring pipe or tubing entries.
6. All differential pressure elements shall have three valve manifolds.

7. All flexible cables and capillary tubing shall be installed in flexible conduits. The lengths shall be sufficient to withdraw the element for periodic maintenance.
8. All power and signal wires shall be terminated with crimped type lugs.
9. All connectors shall be, as a minimum, water tight.
10. All wires shall be mounted clearly with an identification tag that is of a permanent and reusable nature.
11. All wire and cable shall be arranged in a neat manner and securely supported in cable groups and connected from terminal to terminal without splices unless specifically approved by the City Engineer. All wiring shall be protected from sharp edges and corners.
12. All mounting stands and bracket materials and workmanship shall comply with requirements of the Contractor Documents.
13. Verify the correctness of each installation, including polarity of electric power and signal connections, and making sure all process connections are free of leaks. Certify in writing that for each loop or system checked out, all discrepancies have been corrected.
14. The City will not be responsible for any additional cost of rework attributable to actions of the Contractor or the CSI.

3.04 CALIBRATION

- A. General: All devices provided under the instrumentation Sections shall be calibrated according to the manufacturer's recommended procedures to verify operational readiness and ability to meet the indicated functional and tolerance requirements.
- B. Calibration Points: Each instrument shall be calibrated at 0, 50, and 100% of span using test instruments to simulate inputs. The test instruments shall have accuracies traceable to National Institute of Testing Standards.
- C. Bench Calibration: Instruments that have been bench-calibrated shall be examined in the field to determine whether any of the calibrations are in need of adjustment. Such adjustments, if required, shall be made only after consultation with the City Engineer.
- D. Field Calibration: Instruments that were not bench-calibrated shall be calibrated in the field to insure proper operation in accordance with the instrument loop diagrams or specification data sheets.
- E. Analyzer Calibration: Each analyzer system shall be calibrated and tested as a workable system after installation. Testing procedures shall be directed by the manufacturers' technical representatives. All samples and sample gases shall be furnished by the manufacturers.
- F. Calibration Tags: A calibration and testing tag shall be attached to each piece of equipment or system at a location determined by the City Engineer. Have the Instrumentation Supplier sign the tag when calibration is complete. The City Engineer will sign the tag when the calibration and testing has been accepted.

3.05 LOOP TESTING

- A. General: Individual instrument loop diagrams per ISA Standard S5.4 - Instrument Loop Diagrams, expanded format, shall be submitted to the City Engineer for review before the

loop tests. The Contractor shall notify the City Engineer of scheduled tests a minimum of 30 days before the estimated completion date of installation and wiring of the ICM . After the City Engineer's review of the submitted loop diagrams for correctness and compliance with the specifications, loop testing shall proceed. The loop check shall be witnessed by the City Engineer.

- B. Control Valve Tests: All control valves, cylinders, drives and connecting linkages shall be stroked from the operator interface units as well as local control devices and adjusted to verify proper control action, hand switch action, limit switch settings, torque settings, remote control actions, and remote feedback of valve status and position. Control valve actions and positioner settings shall be checked with the valves in place to insure that no changes have occurred since the bench calibration.
- C. Interlocks: All hardware and software interlocks between the instrumentation and the motor control circuits, control circuits of variable-speed controllers and packaged equipment controls shall be checked to the maximum extent possible.
- D. Instrument and Instrument Component Validation: Each instrument shall be field tested, inspected, and adjusted to its indicated performance requirement in accordance its Manufacturer's specifications and instructions. Any instrument that fails to meet any Contractor requirement, or, in the absence of a Contractor requirement, any published manufacturer performance specification for functional and operational parameters, shall be repaired or replaced, at the discretion of the City Engineer at no additional cost to the City.
- E. Loop Validation: Controllers and electronic function modules shall be field tested and exercised to demonstrate correct operation. All control loops shall be checked under simulated operating conditions by impressing input signals at the primary control elements and observing appropriate responses of the respective control and monitoring elements, final control elements, and the graphic displays associated with the SCADA and PLC. Actual signals shall be used wherever available. Following any necessary corrections, the loops shall be retested. Specified accuracy tolerances for each analog network are defined as the root-mean-square-summation of individual component accuracy requirements. Individual component accuracy requirements shall be as indicated by Contractor requirements or by published manufacturer accuracy specifications, whenever Contractor accuracy requirements are not indicated. Each analog network shall be tested by applying simulated analog or discrete inputs to the first element of an analog network. For networks that incorporate analog elements, simulated sensor inputs corresponding to 20, 40, 60, 80 and 100% of span shall be applied, and the resulting element outputs monitored to verify compliance to calculated root-mean-square-summation accuracy tolerance requirements. Continuously variable analog inputs shall be applied to verify the proper operation and setting of discrete devices. Provisional settings discrete devices. Provisional settings shall be made on controllers and alarms during analog loop tests. All analog loop test data shall be recorded on test that include calculated root-mean-square-summation system accuracy tolerance requirements for each output.
- F. Loop Validation Sheets: Prepare loop confirmation sheets for each loop covering each active instrumentation and control device except simple hand switches and lights. Loop confirmation sheets shall form the basis for operational tests and documentation. Each loop

confirmation sheet shall cite the following information and shall provide spaces for sign-off on individual items and on the complete loop by the CSI:

1. Project name
2. Loop number
3. Tag number, description, manufacturer and model number for each element
4. Installation bulletin number
5. Specification sheet number
6. Loop description number
7. Adjustment check
8. Space for comments
9. Space for loop sign-off by Instrumentation Supplier and date
10. Space for City Engineer witness signature and date

- G. Loop Certifications: When installation tests have been successfully completed for all individual instruments and all separate analog control networks, a certified copy of all test forms signed by the City Engineer as a witness, with test data entered, shall be submitted to the City Engineer together with a clear and unequivocal statement that all instrumentation has been successfully calibrated, inspected, and tested.

3.06 PRE-COMMISSIONING

- A. General: Pre-commissioning shall start after acceptance of all wire test, calibration tests and loop tests, and all inspections have demonstrated that the instrumentation and control system complies with all Contractor requirements. Pre-commissioning shall demonstrate proper operation of all systems with process equipment operating over full operating ranges under conditions as closely resembling actual operating conditions as possible.
- B. Pre-commissioning Procedures and Documentation: All pre-commissioning and test activities shall follow detailed test procedures and check lists accepted by the City Engineer as submitted for approval by the CSI. All test data shall be acquired using equipment as required and shall be recorded on test forms accepted by the City Engineer, that include calculated tolerance limits for each step. Completion of all system pre-commissioning and test activities shall be documented by a certified report, including all test forms with test data entered, delivered to the City Engineer with a clear and unequivocal statement that all system pre-commissioning and test requirements have been satisfied.
- C. Operational Validation: Where feasible, system pre-commissioning activities shall include the use of water to establish service conditions that simulate, to the greatest extent possible, normal final control element operating conditions in terms of applied process loads, operating ranges, and environmental conditions. Final control elements, control panels, and ancillary equipment shall be tested under start-up and steady-state operating conditions to verify that proper and stable control is achieved using motor control center and local field mounted control circuits. All hardwired and software control circuit interlocks and alarms shall be operational. The control of final control elements and ancillary equipment shall be tested using both manual and automatic (where provided) control circuits. The stable steady-state operation of final control elements running under the control of field mounted automatic analog controllers or software based controllers shall be assured by adjusting the controllers as required to eliminate oscillatory final control element operation. The transient

stability of final control elements operating under the control of field mounted, and software based automatic analog controllers shall be verified by applying control signal disturbances, monitoring the amplitude and decay rate of control parameter oscillations (if any) and making necessary controller adjustments as required to eliminate excessive oscillatory amplitudes and decay rates.

- D. Loop Tuning: All electronic control stations incorporating proportional, integral or differential control circuits shall be optimally tuned, experimentally, by applying control signal disturbances and adjusting the gain, reset, or rate settings as required to achieve a proper response. Measured final control element variable position/speed set point settings shall be compared to measured final control element position/speed values at 20, 40, 60, 80 and 100% of span and the results checked against indicated accuracy tolerances.
- E. Pre-commissioning Validation Sheets: Pre-commissioning shall be documented on one of two types of test forms as follows:
 - 1. For functions that can be demonstrated on a loop-by-loop basis, the form shall include:
 - a. Project name
 - b. Loop number
 - c. Loop description
 - d. Tag number, description, manufacturer and data sheet number for each component.
 - e. Space for sign-off and date by both the CSI and the City Engineer.
 - 2. For functions that cannot be demonstrated on a loop-by-loop basis, the test form shall be a listing of the specific tests to be conducted. With each test description the following information shall be included:
 - a. Specification page and paragraph of function demonstrated
 - b. Description of function
 - c. Space for sign-off and date by both the CSI and the City Engineer.
- F. Pre-commissioning Certification: Submit an ICM system pre-commissioning completion report that shall state that all Contractor requirements have been met and shall include a listing of all instrumentation and control system maintenance and repair activities conducted during the pre-commissioning testing. Acceptance of the instrumentation and control system pre-commissioning testing must be provided in writing by the City Engineer before the performance testing may begin. Final acceptance of the control system shall be based upon plant completion as stated in the Service Contract.

3.07 ON SITE SUPERVISION

- A. Furnish the services of an on-site service engineer to supervise and coordinate installation, adjustment, testing, and start-up of the ICM system. The City Engineer will be present during the total period required to effect a complete operating system. A qualified team of the Instrumentation Subcontractor personnel shall be on site as required to check all equipment, perform the tests indicated in this Section, and furnish startup services.

3.08 PERFORMANCE TEST

- A. The entire ICM system shall operate for 30 days without failure.
- B. Furnish all necessary support staff as required to maintain the system and to satisfy the repair or replacement requirements.
- C. If any component fails during the performance test, it shall be repaired or replaced within 4 hours and the ICM system shall be restarted. If the system is not repaired and running within four (4) hours the system shall be restarted and operate for an additional 30 days without failure.

3.09 TRAINING – NOT USED

3.10 ACCEPTANCE

- A. For the purpose of this Section, the following conditions shall be fulfilled before the Work is considered substantially complete:
 - 1. All submittals have been completed and approved.
 - 2. The ICM system has been calibrated, loop tested and pre-commissioned.
 - 3. All required spare parts and expendable supplies and test equipment have been delivered to the City.
 - 4. The performance test has been successfully completed.
 - 5. All punch-list items have been corrected.
 - 6. All record drawings in both hard copy and electronic format have been submitted.
 - 7. Revisions to the operations and maintenance manuals information that may have resulted from the field tests have been made and reviewed.
 - 8. All debris associated with installation of instrumentation has been removed.
 - 9. All probes, elements, sample lines, transmitters, tubing, and enclosures have been cleaned and are in like-new condition.

3.11 WARRANTY

- A. Supplier shall warrant design, materials, and workmanship for customary period applicable for the equipment involved, but in no case for less than twelve months from date of acceptance.
- B. During warranty period, if mechanical defects occur, or equipment fails to perform in accordance with specified performance requirements under conditions of normal use within the design limitations of the equipment, supplier shall, upon request of the Contractor, repair or replace equipment or parts as required and shall place equipment in proper working condition, assuming all expenses involved.
- C. A written prepaid maintenance contract executed by the CSI shall be provided to the City for on-site warranty and travel maintenance services. This maintenance contract shall include all travel and living expenses, labor, parts, and emergency calls providing on-site response within 4 hours, to provide complete system maintenance for a period of one year after the date of final acceptance of the system.

- D. The maintenance contract shall include a minimum of 4 (quarterly) preventive maintenance visits by a qualified serviceman of the Supplier who is familiar with the type of equipment and software provided for this project. Each preventive maintenance visit shall include routine adjustment, calibration, cleaning, and lubrication of system equipment and written verification of calibration and correct software operation.
- E. An annual fee shall be quoted 90 days before completion of the first year maintenance contract for annual maintenance subsequent to the first year of operation. Standard per diem rates for providing breakdown service shall be set forth in the contract. Such rates shall be fair and reasonable and reflect the lowest rates offered to most favored customers. The fee quoted shall be firm for a minimum of 90 days from day of issue.

END OF SECTION